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PATENT SPECIFICATION 720,390

Date of Application and filing Complete Specification: May 7, 1951.
No. 35224/53.
Application made in United States of America on Oct. 7, 1950.
(Divided out of No. 720,364).
(Patent of Addition to No. 720,363 dated Feb. 23, 1951).
Complete Specification Published: Dec. 15, 1954.

Index at acceptance:—Class 81(2), B1M.

COMPLETE SPECIFICATION

Tampons and like Absorbent Pads

We, TAMPAX INCORPORATED, a corporation organised and existing under the laws of the State of Delaware, United States of America, of Palmer, Massachusetts, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to absorption devices adapted for body fluid absorption, and more particularly to compressed absorbent fiber devices as surgical pads, dental rolls, catamenial pads, vaginal tampons, and the like (all of which will be referred to generally as "absorbent pads") in which the fluid-absorbing means comprises a shaped mass of absorbent cotton or like absorbent fiber.

Although it is desirable that vaginal tampons especially be capable of absorbing as much fluid as possible, it is ordinarily essential that they be limited to very small bulk to avoid discomfort. We have found that there is a critical or optimum relation between the bulk or apparent density of the absorbent fiber mass of such an absorbent pad and the absorbency thereof. If for a given size tampon, too much fiber is compacted into its volume, it loses much of its permeability to liquid and is relatively un-absorbent, and on the other hand if it is not compacted the amount of fiber in the mass may be too small to retain the required amount of fluid in the interstices. In the case of vaginal tampons, moreover, it is important that the fibrous mass before use have substantial rigidity to facilitate insertion into the vaginal cavity, and that it have such stability in its compact form that it can be supplied in a tube and will not expand too tightly against the inside of the tube. It is difficult, however, to make the fiber retain just the degree of compression desired.

It is possible with sufficient compression to overcome the resiliency of the fibers and give a mass which remains dense. It has been demonstrated, however, that the compression of untreated fibers necessary to achieve such stability of form and dimensions (i.e. to overcome inherent resiliency of the fibers tending to spring back to a larger loose mass after compression) may be so great that the density of the resulting absorbent pad precludes maximum absorbency, i.e., because it is too tightly compressed, with too little air space between the individual fibers so that actually it absorbs less fluid than a smaller amount of fiber in a less dense mass.

According to this invention an absorbent pad of a predetermined size is made of a particular density such that it is compacted yet readily permeable to the fluid, by compressing a mass of absorbent fibers under conditions which produce a stable "set" in the fibers without destroying their "elastic memory," that is the property of retaining elasticity whereby, when they are wet with the fluid the set is released, and the fibers tend to return to the form which they had before compression. In order to facilitate setting of the fiber under the compression of the particular density, the fiber is treated according to our invention with a compression-stabilising agent as hereinafter set forth. By this treatment a stable set of the fiber can be obtained in a tampon with a lower density.

The specification of our copending Application No. 4435/1951 (Serial No. 720,363) describes a process for increasing the fluid retentivity of absorbent pads by treating them with polyhydric alcohol retention agents. We have found that these same agents can serve for achieving the compression stabilisation according to this invention.

Accordingly, the present invention consists in an absorbent pad treated with a polyhydric alcohol retention agent according to application No. 4435/1951 (Serial No. 720,363), which is compression-stabilised at a volume corresponding to a density less than that which can be stably held by compressing dry untreated fibers.

= US 2849000 (R98-355)

We have discovered and proven that the problem is somewhat analogous to the creasing of textile fabrics, in that both involve the ability of the fibers to take a "set" in a bent form produced by pressure on the fibrous mass and in both cases the resiliency of the fiber and permeability of the fibrous mass must not be destroyed; in the present case there is no creasing desired and the primary purpose of absorbency is one which would be undesirable in the creasing of fabrics; in addition there is here a requirement that the material must possess pharmaceutical properties, i.e., compatible with living tissue with which it must remain in contact and that it must be compatible with the body fluids to be absorbed, i.e., must not form with them a precipitate or coagulant inimical to absorption. It should not be an adhesive or at least any adhesive effect should be promptly released when wet with body fluid.

Accordingly, a principal object of this invention is to provide absorbent pads of relatively high absorption efficiency, and particularly pads for absorption of fluids in body cavities, such as vaginal tampons, dental rolls and the like.

Another object is to provide a compressed absorbent pad with stability of form and dimensions, and specifically to provide a tampon which can be expelled from the tube in which it is supplied with less force than is usually required.

A further object of this invention is to provide an absorbent pad of normally resilient and absorbent fibers which will retain a predetermined size and density after compression and yet in use will be expandable to receive a maximum amount of absorbed body fluid.

Another object of this invention is to provide an improved highly absorbent vaginal tampon of a conveniently small size in stable compressed form and with a fiber mass sufficient for required vaginal fluid absorption and retention.

Another object is to increase the absorption efficiency of compressed tampons.

Another object of the invention is to provide compressed absorbent pads and the like which are stable so far as retention of compressed density are concerned.

Other objects of the present invention and advantages in use will more clearly appear from the following description of a typical embodiment. It will be understood that the invention is capable of many different embodiments and that the following description is not intended to be exhaustive or limiting.

It is evident that the appropriate size of an absorbent pad or tampon in compressed form is determined by its intended use (e.g. the size of a vaginal tampon should be one with as much fiber as can be comfortably inserted and worn in the vagina of a particular individual). Thus it would seem apparent that the more fiber which could be compressed into the tampon of given size the more fluid it could absorb and retain.

In the process heretofore employed in manufacturing vaginal tampons, compression-stability is imparted to the mass of absorbent cotton fibers by a high compression. By use of a compression-stabilising agent according to this invention, one can form the tampons with optimum density using a lesser pressure.

For this purpose a compression-stabilising substance is employed as stated above, to modify the resiliency of the fibers of the treated mass so that they will retain their compressed form, substantially stable during storage before use, and yet will retain a "memory" of their original loose form which is released when they are wet, so that they expand and take up fluid, thus providing maximum absorption capacity in use. Such a compression-stabilising material should be hydrophilic. If the pad or tampon is to be used in a body cavity, or for like use the stabilising material must, of course, be wholly safe, non-irritating and non-toxic. Such stabilising material advantageously is one which is taken up by the fiber and can be effective in minute amounts, advantageously without leaving more than a microscopic or monomolecular film or deposit on the individual fibers, but that amount should be strongly held so that it does not evaporate from the fiber.

The class of materials which we have found effective are those which produce a crease stabilisation in the fibers, i.e., put the fiber into condition to take a set upon hot pressing below the temperature of full plastic flow of the fiber. Representative materials which we have found effective for this purpose are:

Alcohols:	
Polyvinyl alcohol	¼%.
Hexahydric:	
Sorbitol	½—4%.
Trihydric:	
Glycerine	1/10—20%.
Dihydric:	
Ethylene Glycol	½—2%.
Propylene Glycol	¼—4%.
Butylene Glycol	½%
Diethylene Glycol	½—4%
Dipropylene Glycol	1—4%.
Triethylene Glycol	½—2%
Tetraethylene Glycol	½—2%
Polyethylene Glycol ("Carbowax" 1500)	½—2%

Monohydric alcohols can be used but are not recommended as the lower alcohols are too volatile, those of intermediate molecular weight generally have objectionable odour or other objectionable properties, and the higher alcohols are water repellant.

Glycol Ethers:	
Diethylene glycol ethyl ether (Carbitol)	½—¾%.

The concentrations given above are by weight based on the weight of the compression-stabilising agent supplied to the fiber, whether alone or in solution, and the weight of the fiber on an air-dry (5% moisture) basis. The percentages given do not exclude the use of greater or lesser amounts; tests have shown that in general a percentage between ¼% and 1% is most satisfactory, and, although in some cases good results have been obtained with as much as 20% of the agent, the additional agent beyond 1% has not shown enough improvement to justify its cost. In many cases a maximum effect is reached generally in the range ¼—4%, after which additional agent actually impairs the desired effect. One or more of such compounds may be used, the total amount being, advantageously, within these percentage ranges.

Of the compounds, glycerine, butane diol, ethylene and propylene glycols, diethylene glycol, polyethylene glycol, Carbitol, and isopropyl alcohol, are best from the point of view of compression stabilisation and isopropyl alcohol, butane diol, glycerine and sorbitol, are best from the point of view of increased absorbency. There appears to be advantage in applying these materials during the final washing of the fiber, i.e., by washing with a solution of the agent. A substantial proportion of the agent will be lost in the wash water and in evaporation, but a sufficient proportion is held on the fiber as a film and the subsequent treatment of the fiber distributes mechanically any unevenness in application and the heat involved in drying etc. accelerates bonding of the agent to the fiber.

These materials are all water-soluble, and they are advantageously applied to the fibers in water solution, although in some instances direct application to the fibers without a solvent may be carried out as noted below.

The compression-stabilising material is advantageously applied to unspun, absorbent cotton fibers in sliver bats or the like before the pads or tampons are cut, compressed, and formed into their final shape.

A solution of the agent is conveniently used as the final wash solution applied to the cotton immediately ahead of squeeze rolls through which the cotton passes as a final step prior to drying. It has been found that approximately 100 cc. of solution is retained by approximately 100 grams of absorbent cotton after squeezing; the water is then dried from the retained solution.

In situations where the viscosity of the stabilising material is sufficiently low to penetrate the mass of fibers satisfactorily (e.g., where the process is carried out at elevated temperatures) the compression-stabilising agent may be directly applied to the fibers, as by spraying, without dissolving in water or other diluent. Other solvents than water (e.g., alcohol) may satisfactorily be employed in the treating solution, but water is preferred because of its convenience and low cost and because it obviates many problems of solvent elimination or recovery.

After the solution of compression-stabilising agent is applied, the fiber mass is dried, e.g., in the usual manner. Satisfactory results are obtained with temperatures ranging from 240° F. at the wet end of a conventional hot air drying tunnel to approximately 212° F. at the dry end of the tunnel, with the cotton passing through this range of temperatures in approximately one-half hour.

It may often be advantageous to apply more of the agent than is needed and then remove the excess by evaporation or washing. It has been determined, for example, that cotton containing glycerine in concentrations of 0.5% to 10% when dried at 240° F. for 4 hours may lose as much as 50% to 75% of the originally applied glycerine. Utilising the half-hour drying procedure above noted on production scale, the cotton fibers may lose as much as 50% of the originally applied glycerine. It appears, however, that the necessary amount of compression-stabilising agent becomes quite stably held by the fibers so that after an excess is evaporated, substantially no further noticeable loss occurs. Thus with an excess of glycerine applied in solution and held for several minutes on cotton fiber, even after heating many hours at as high a temperature as 260° F., 0.37% of glycerine (based on the air-dry weight of fiber) remains. It is probable that this is only slightly less than the optimum amount of the agent. At least part of this is probably held in a monomolecular layer on the fiber surface, which aids the capillary absorbency of the compressed mass. It is also probable that a part enters the fiber by diffiusion to modify its resiliency characteristic so as to give it compression stability at the lower density desired for improved absorbency.

Evaporation losses should of course be considered in determining the amount of treating material applied to achieve the desired stabilising agent concentration on the fibers of the finished absorbent pads.

After the uncut and unformed bats of absorbent cotton fibers are completely processed and treated with the compression-stabilising agent as noted above, the bats are cut into pads, e.g., tampon blanks, and compressively formed into a desired size and shape by conventional means—for example, between conventional compression dies by methods well known in the art. By way of illustration, a convenient method of forming absorbent cotton fibers into a compressed, generally cylindrical tampon is indicated in U.S.A. patents to Voss, No. 2,076,389, April 6, 1937, and McLaughlin No. 2,416,706 March 4, 1947. As shown by these patents,

the loose cotton bats are fed in between compression dies which impart the desired shape and degree of compression for the desired density of the compressed tampon. While still under the compressing force of the dies, the tampon is ejected into a cylindrical chamber where the compression and shape of the tampon are maintained for about one-half minute (plus or minus 10 seconds), and where it is heated, for example at about 70—90° C. to set the cotton fiber mass in compressed form. The final tampon may have a density in the range 0.31 to 0.58 grams per cubic centimeter of overall volume.

An absorbent cotton tampon made by mere compression and heating without the treatment of this invention would have a tendency to fluff out or expand to a size greatly in excess of the compressed size upon being ejected from the heated chamber mentioned above, and if it is held by a tubular container its pressure against the walls makes it difficult to eject.

Utilising this invention, however, the inherent resiliency of cotton fibers of the tampon is overcome and the tampons are caused to retain their compressed configuration so that, upon ejection from the compressing apparatus and after compressing and retaining forces are removed, the tampon will still retain its compressed size without excessive pressure against the container. Yet the compression-stabilising materials of this invention are such that the effect is overcome or released by saturation or direct contact of the fibers with body fluid, and such saturation or spreading of the fluid over the fibers is directly promoted by the compression stabilising agent, whereupon the tampon expands sufficiently to provide in use maximum absorbency of body fluid.

It will be understood that compressing techniques other than those referred to in the above-mentioned U.S.A. patents, given by way of illustration, may be used in carrying out this invention, which is not limited to the specific details set forth above.

Satisfactory results have been obtained using the materials set forth above as compression stabilising agents in concentrations of from 0.1% to 5% or higher. Although materials generally such as those set forth above have been found to give satisfactory results in residue concentration ranges similar to those set forth, approximately 0.25% (based on air-dry weight of fiber treated) may be considered a satisfactory minimum concentration and approximately 2% a maximum concentration for general use in commercial operations.

It will also be understood that the compression-stabilising material may satisfactorily be applied to the cotton fibers at some stage in the processing thereof other than during the last washing step as described above. These agents, with or without dilution may be applied as a spray or vapour in conventional carding or other steps in which cotton fibers suitable for tampons or the like are subjected to rubbing along their surfaces which blends the agent with the cotton fibers and thus overcomes inequalities or non-uniformity in application.

Although the exact scientific reason for the surprising results in size stability and improvement in absorbency obtained by treating the fibers according to this invention is not now certainly known, the following hypothesis is suggested. It has been noted that chemical agents of the character set forth, when applied to cellulose fibers according to this invention apparently become more strongly bonded to the fibers the longer they remain in contact therewith, so that the treatment appears to be more than a mere temporary inter-fiber entrapment of treating material by the mass of fibers. The apparent "setting" produced according to this invention suggests that some alteration of the fibers themselves, or at least an alteration in their inherent resiliency takes place. But the fact that the fiber mass expands upon contact with body fluid indicates that any structural or chemical alteration or surface phenomenon that may occur as a result of the described treatment is a releasable one.

In any case, however, this invention produces a stable tampon of desired size and optimum density containing, for example, in a standard size tampon, as little as 2.3 grams of absorbent cotton, whereas not less than 4 grams of fiber was formerly required to produce a tampon of the same size and comparable stability by compression pressure alone without use of the stabilising agent.

While particular embodiments of the invention have been described, it is to be understood that various modifications may be made without departing from the scope of the invention which is defined in the appended claims.

The specification of our copending Application No. 10699/51 (Serial No. 720,364) describes and claims the method of making an absorbent pad of inherently resilient fibers, which comprises distributing onto such fibers a non-toxic, non-irritating, hydrophilic compression-stabilising agent, compatible with body fluids to be absorbed by the pad, compressing a predetermined weight of said fibers into a predetermined volume corresponding to a density less than that which can be stably held after compression of dry untreated fibers and holding the resulting mass of fibers under compression until it becomes set with said predetermined volume.

What we claim is:—

1. An absorbent pad treated with polyhydric alcohol retention agents according to Application No. 4435/51 (Serial No. 720,363) which is compression - stabilised at a volume corresponding to a density less than that

which can be stably held by compressing dry untreated fibers.

2. An absorbent pad as claimed in claim 1, which is compressed to a substantially self-sustained density in the range of 0.31 to 0.58 grams per cubic centimeter of overall volume.

3. An absorbent pad comprising a mass of absorbent cotton of which the fiber carries therein a ¼ to 4% of a material selected from the group consisting of water-soluble alcohols, glycerine, glycols, and glycol ethers, the pad being compression-stabilised at a volume corresponding to a density in the range 0.31 to 0.58 grams per cubic centimeter of overall volume.

4. A compression-stabilised absorbent pad substantially as hereinbefore described.

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